Space Weather Technical Forecast

Issued on Monday, 20 May 2024 at 12:23 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of isolated M-class flares throughout. Chance of G1-G2 (Minor/Moderate) Storm conditions Days 1-3 (from 20th to 22nd May).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate, the strongest flare being an M2.5 that occurred at 19/1756 UTC from AR3685. The latest flare was a C6 that occurred at 20/0554 UTC from AR3683.

There are currently seven sunspot regions on the visible disc. The largest region remains AR3685 in the southeast. It comprises of a number of large, mature spots, with recent consolidation of some of the smaller spots. This region did consist of a small delta spot, which has now faded. AR3679, in the southwest, is the next largest region and has been the source of some low-level C-class activity. Although the main lead and trailer regions are well-separated there are a number of small pores or spots of mixed polarity occupying the intermediate portion of the group. AR3683 in the southwest indicates modest magnetic complexity, with numerous small trailing spots and some consolidation. The other sunspot regions are generally smaller, simpler and generally stable.

A large filament lift-off from the southern hemisphere that began around 18/2200UTC has been modelled as missing below Earth orbit. Another large filament eruption was observed after the C6 flare that occurred at 20/0554 UTC from AR3683 in the southwest. We are currently awaiting the results of the analysis but given its location and early imagery, it is likely to have an Earth-directed component. Otherwise, no Earth-directed CMEs were observed in the past 24 hours in coronagraph imagery.

Solar Wind / Geomagnetic Activity: Solar winds observed by ACE at L1 were indicative of a near background regime, though perhaps with minor positive coronal hole influence. Solar wind speeds have ranged between 340-410km/s. Density of the solar wind was predominantly below average and well below 5ppcc most of the time. The Interplanetary Magnetic Field (IMF), Bt, was in between weak and moderate, around 8nT. The north-south component Bz was stable and fluctuating slowly from +/-7nT during the period. Phi angle was predominately positive (away from the Sun). Geomagnetic activity was at Quiet to Unsettled levels (Kp1-3).

Energetic Particles / Solar Radiation: High energy proton flux (greater than 10 MeV) remained below the S1/Minor Radiation Storm levels and are now at normal background levels. High energy electron flux (greater than 2MeV) observed by GOES-16 was at background to moderate levels, with a peak of 406 pfu at 19/1800UTC. The associated 24-hour fluence has remained below the Active threshold. Observed fluence at 20/0000 UTC of 9.78e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Low to Moderate activity is expected with a chance of isolated M-class flares and a very slight chance of isolated X-class flares. AR3685 is most likely to be the source of

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significant flare activity.

Solar Wind / Geomagnetic Activity: There is the chance of a glancing blow from a CME at Earth late day 1 (20 May) or perhaps early day 2 (21 May), resulting from the M7.2 flare of AR3685 that occurred late on 17 May. We are also awaiting the results of the analysis from the halo CME that occurred earlier today (20/05:54 UTC) but there is potential for Earth to take another glancing blow on Day 3 (22nd). In the meantime, solar winds are forecast to remain at or near background speeds, with no significant coronal hole enhancements expected.
Quiet to Unsettled conditions initially, before a possible glancing blow from a CME (which left the Sun on 17 May) arrives at Earth late day 1 (20th) or early day 2 (21st) with a chance of Active to G1-G2/Minor-Moderate (Kp5-6) intervals. Another chance of G1-G2/Minor-Moderate Storm is possible at the end of Day 2 (21st) and on Day 3 (22nd), under the influence of the halo CME. Activity should then subside towards Quiet to Unsettled levels by Day 4 (23rd).

Energetic Particles / Solar Radiation: Proton flux is below the S1/Minor Storm threshold, on a slightly declining trend, but remains just above normal background levels following flare activity from the past week. There is a persistent slight chance of further enhancements should any large flares occur.

High energy electron flux is at background to moderate levels. There is the potential for the electron flux to rise and potentially reach high levels at the end of the period but the chance is considered low since any enhancement is likely to be curtailed by CME influences over the following days. The associated 24 hour fluence is expected to remain well below the Active threshold, even if it is likely to rise at the end of the period. The risk of exceeding the Active threshold is low but considered possible on Day 4 (23rd) though dependent on the extent of any CME enhancement.

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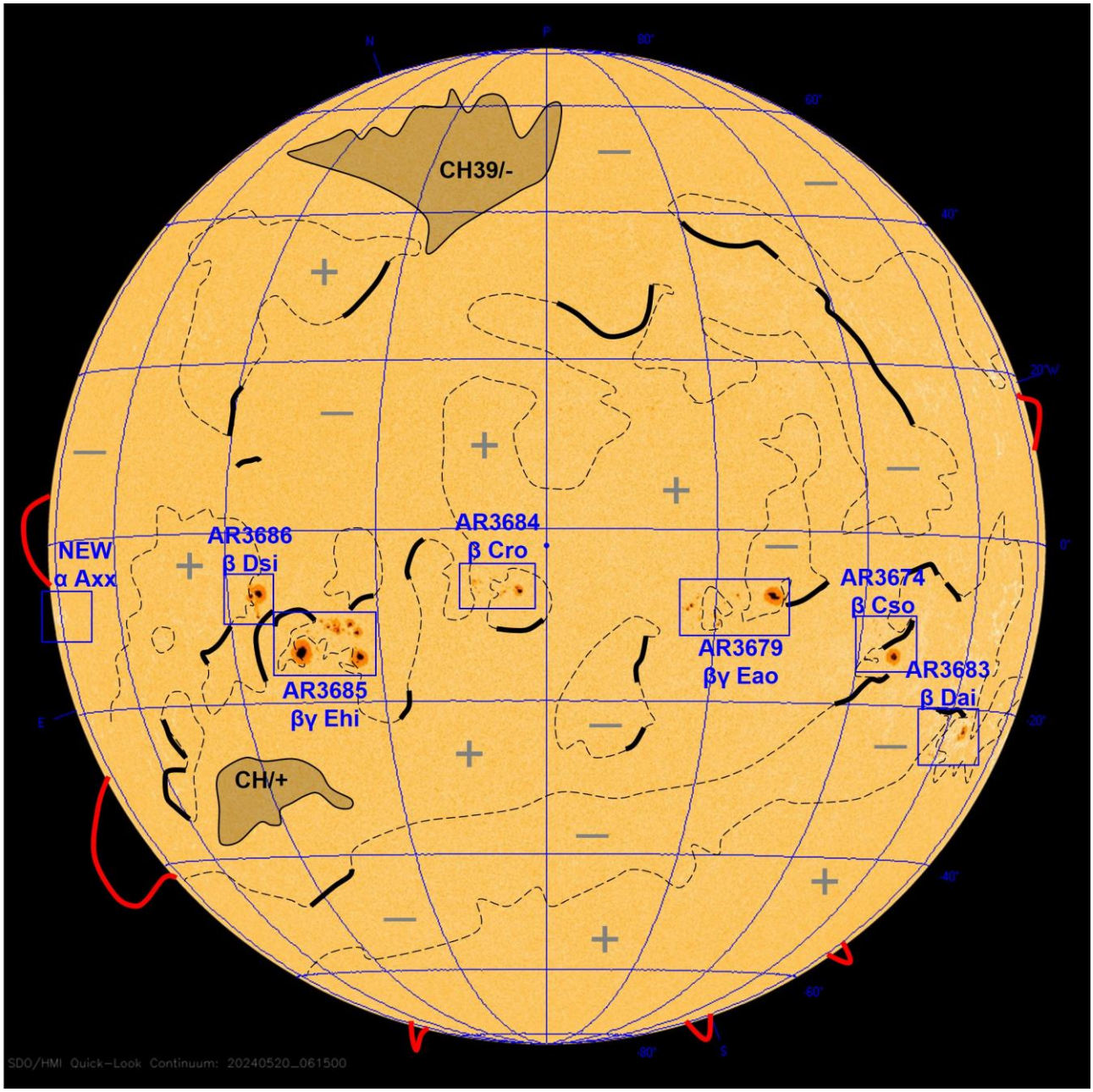
Figure 1. Solar Analysis Valid 20/0800 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

One potentially Earth-directed CMEs currently features in the forecast period. Late on 17 May a complex 'double-structured' moderately-fast CME was seen in coronagraph imagery associated with the M7.2 flare of AR3685 in the southeast disc. Type II and IV Radio Emissions as well as a distinct EUV wave signature were observed. Modelling of this feature suggests the potential for a glancing impact late day 1 (20 May) or perhaps early day 2 (21 May).

We are also awaiting the results of the analysis from the halo CME that occurred earlier today (20/05:54 UTC) but there is potential for Earth to take another glancing blow on Day 3 (22nd). In the meantime, solar winds are forecast to remain at or close to background speeds, with no significant coronal hole enhancements expected.

Quiet to Unsettled conditions initially, before a possible glancing blow from a CME (which left the Sun on 17 May) arrives at Earth late day 1 (20th) or early day 2 (21st) with a chance of Active to G1-G2/Minor-Moderate (Kp5-6) intervals. Another chance of G1-G2/Minor-Moderate Storm is possible at the end of Day 2 (21st) and on Day 3 (22nd), under the influence of the halo CME. Activity should then subside towards Quiet to Unsettled levels by Day 4 (23rd).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	50	50	50	1
Strong	G3	No	10	10	10	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
18/0039	Partial	AR3665	SE	950 km/s	20/2000 UTC	Chance of glancing impacts

Figure 2: MOSWOC Enlil and Ensemble, which shows the M7.2 flare CME passing mostly behind and

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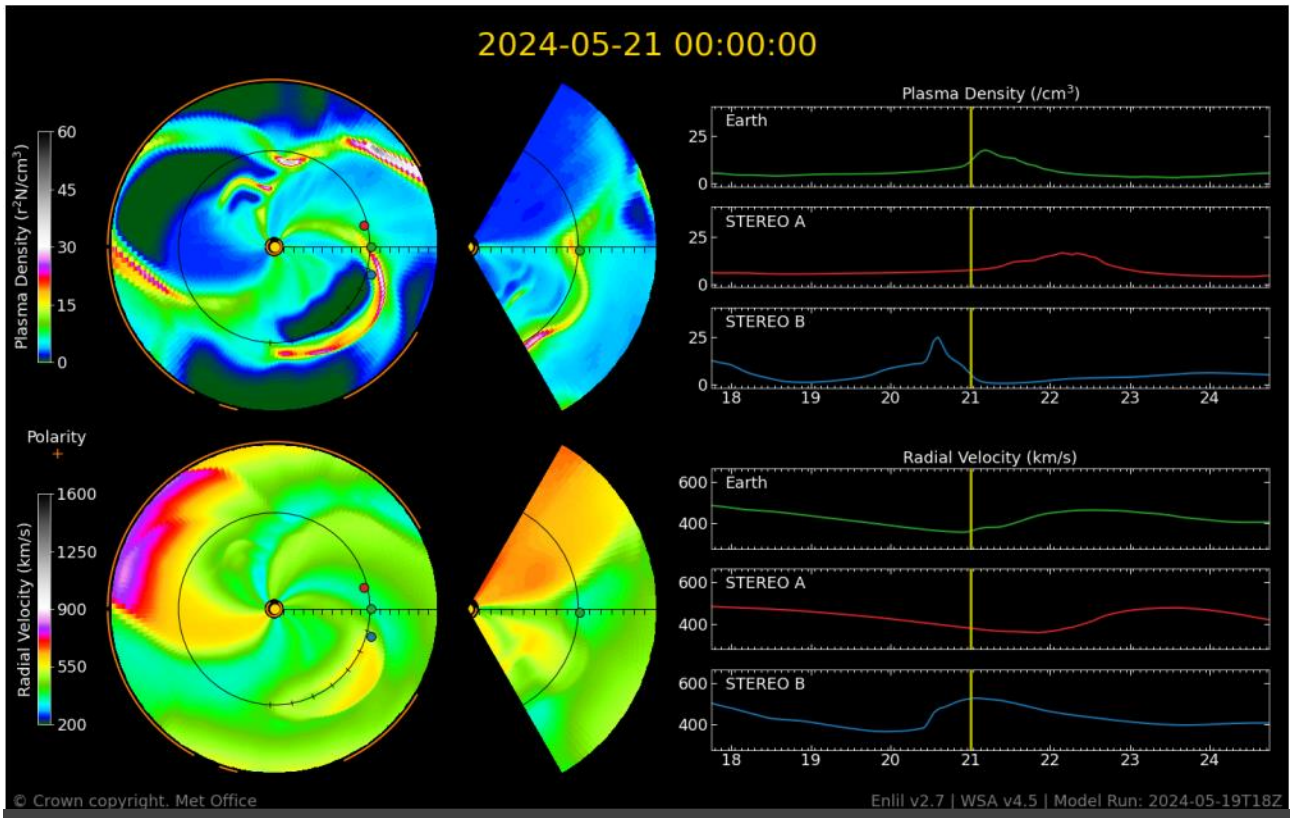
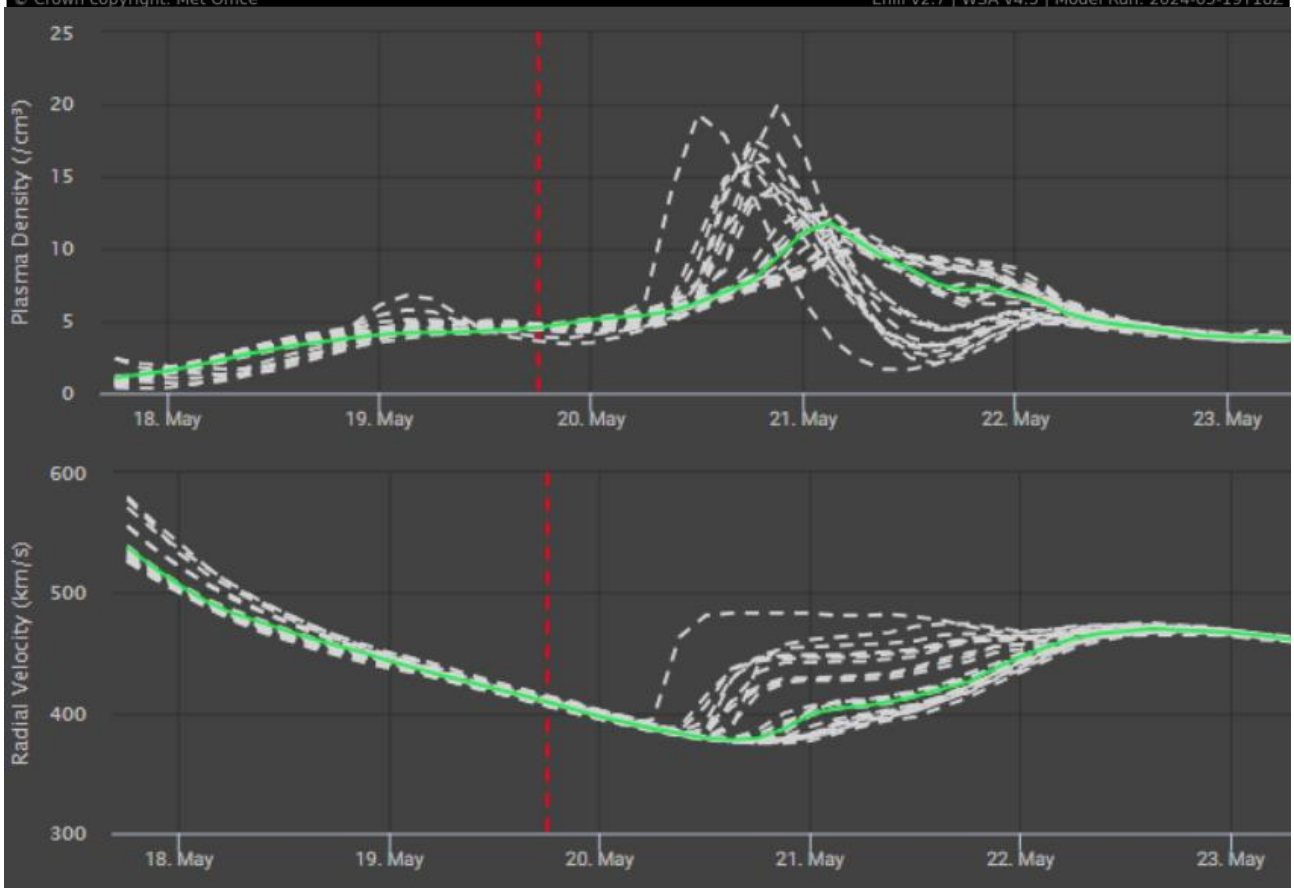
below Earth' orbit late on 20 May or early 21 May, with a possible glancing blow.





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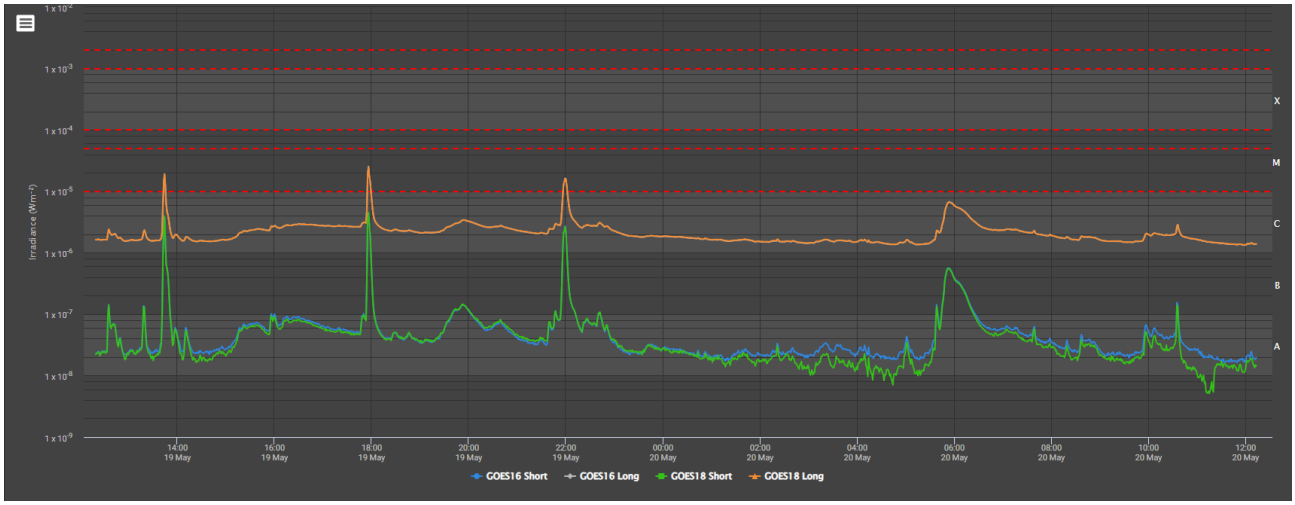
Radio Blackouts - X-Ray Flares:
There are currently seven sunspot regions on the visible disc. The largest region remains AR3685 in the southeast. It comprises of a number of large, mature spots, with recent consolidation of some of the smaller spots. This region did consist of a small delta spot, which has now faded. AR3679, in the southwest, is the next largest region and has been the source of some low-level C-class activity. Although the main lead and trailer regions are well-separated there are a number of small pores or spots of mixed polarity occupying the intermediate portion of the group. AR3683 in the southwest indicates modest magnetic complexity with numerous small trailing spots and some consolidation. The other sunspot regions are generally smaller, simpler and generally stable.

No significant returning regions are expected through the period or strongly signalled in far-side sounding data, with all the current notable flare producing regions remaining on the visible disc though the next four days. As such, the current flare risks have been maintained through the period pending further developments.

Low to Moderate activity is expected with a chance of isolated M-class flares and a very slight chance of isolated X-class flares. AR3685 is most likely to be the source of significant flare activity.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	60	60	60	60
Very Active	R3 to R5 X Class	No	5	5	5	5

Figure 3: Latest GOES-18 X-Ray flares



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Solar Radiation Storms - (High Energy Protons):

Proton flux is below the S1/Minor Storm threshold, on a slightly declining trend, but remains just above normal background levels following flare activity from the past week. There is a persistent slight chance of further enhancements should any large flares occur, especially given the number of sunspot regions on the Earth-facing disc. AR3685, the largest and most actively flaring region on the disc will, however, remain in a generally unfavourable position (in the eastern hemisphere) for significant proton enhancement throughout.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	10	10	10	10
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux, as observed by GOES-16 is at background to moderate levels. There is the potential for the electron flux to rise and potentially reach high levels at the end of the period but the chance is considered low since any enhancement is likely to be curtailed by CME influences over the following days.

The associated 24 hour fluence is expected to remain well below the Active threshold, even if it is likely to rise at the end of the period. The risk of exceeding the Active threshold is low but considered possible on Day 4 (23rd) though dependent on the extent of any CME enhancement. In the absence of CME enhancements MOSWOC REFM looks to be providing reasonable guidance, although perhaps slightly over representing the risk of reaching the Active threshold later in the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	10	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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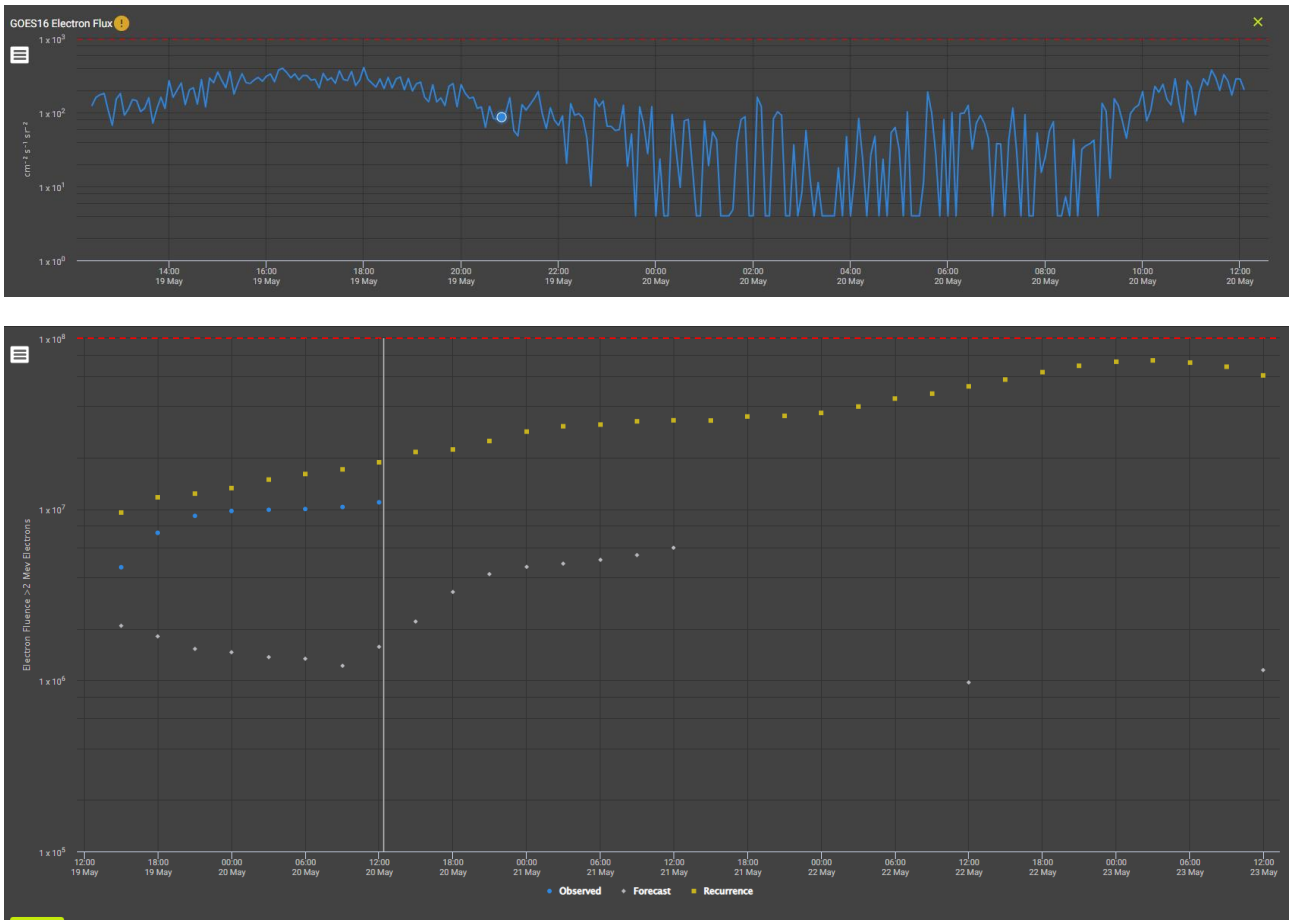
Figure 4: GOES-16 >2MeV Electron Flux (top) and MOSWOC REFM forecast (bottom).



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